Burned Area Emergency Response (BAER) Assessment
Specialist Report, Phase 2 – GEOLOGIC HAZARDS

Thomas Fire, Los Padres National Forest
January 2018

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Fire-damaged Tree near Chismahoo Mountain

“When rain starts to fall, people in higher risk basins should be prepared to evacuate. Do not remain in, near or below burned areas at the base of canyons, even during light rain. Stay away from small streams that could become raging rivers in the blink of an eye. If the forecast calls for heavy rains through the night, homes may not be safe places if they are located in or near drainage areas and within a mile of the mountain front. Roads can suddenly become blocked with mud and debris, and can wash out at stream crossings. It is important to pay strong attention to warnings from local emergency responders and weather advisories.”

-Sue Cannon, USGS Landslide Hazards Program, 2003

INTRODUCTION

The Thomas Fire started on December 4, 2017, near the Thomas Aquinas College (east end of Sulphur Mountain), Ventura County, California. The fire is still considered to be active and as of January 12th, 2018, it is estimated to have burned 281,900 acres and is 92% contained. Approximately 181,300 acres within the burn area are National Forest lands (~64%); 98,200 acres are private (~35%); and 2,400 acres (~1%) are a combination of state and county properties. Although tremendous down-slope/down-drainage resources and values and lives are recognized and kept in mind during our analysis, this report addresses the effects of the Thomas Fire and the associated Values At Risk (VARs) ONLY on Forest Service lands, since the other lands are being evaluated by teams of Cal Fire scientists and other agencies. This analysis does not assess the private lands below Forest Service land, but discusses the conditions on the Forest Service uplands which will affect life and properties below for the next 2 to 3 years, or longer, until vegetation re-establishes.

This is, to date, the largest wildland fire in California history.

This report covers the second of two phases of the BAER team assessment and encompasses approximately 140,000 acres within 20 6^{th} field (HUC) watersheds. The phase 1 report was completed by Yonni Schwartz in late December, 2017, and covers 40,271 acres of USFS land.

METHODS

The field data collected for this project was recorded from personal observations taken primarily adjacent to county and Forest Service roads, along with a helicopter overflight of the burn area. A total of six person days were spent in the field, and two person days were devoted to validating the debris flow model outputs. Notes, maps, and photographs documenting field observations are filed with the project record. The Forest GIS coverages for bedrock and geomorphology were examined on-screen with fire severities superimposed to identify areas where unstable land was severely burned. The US Geological Survey graciously ran their debris flow model on the Thomas fire and provided results to the BAER team. See **Outputs of the USGS Debris Flow Model** in the report below.

RESOURCE SETTING

Geology and Geomorphology:

The area that is being analyzed is within the western Transverse Ranges of Santa Barbara and Ventura Counties which is considered a tectonically active area and is experiencing rapid uplift and consequent down-cutting. The topography in this area ranges from over 6000 feet above sea level at Monte Arido, down to near sea level along Highway 101. Many of the slopes above the Ojai Valley and Wheeler Gorge are over 80 percent in gradient, which create a very steep and rugged terrain. The major drainages analyzed for the purposes of this assessment are Santa Paula Creek, North Fork Matlija Creek, Matilija Creek, Santa Ynez River, San Antonio Creek and Upper

Ventura River, Upper Sespe Creek, Lower Sespe Creek and Timber Canyon, Coyote Creek, Santa Ynez River, and the Pacific Frontal watersheds.

The studied area is underlain entirely by alternating sedimentary Sandstone and Shale rock formations, ranging in age from Cretaceous (83-65 million years ago) to Pliocene (5.3-2.5 million years ago) epochs, and overlain by Quaternary alluvial and surficial sediments and slide deposits to present age. Invariably, rock formations mapped as sandstone have thinner inter-beds of shale, and formations mapped as shale have relatively thinner inter-beds of sandstone (Dibblee, 1966). Geologic formations frequently aligned with an E-W orientation, but outcrops frequently are faulted and folded into other orientations (Figure 1). Slopes are extremely steep in many locations, as described within the Watershed descriptions.

Geologic Hazards

When evaluating Geologic Hazards, the focus of the "Geology" function on a BAER Team is on identifying the geologic conditions and geomorphic processes that have helped shape and alter the watersheds and landscapes, and assessing the impacts from the fire on those conditions and processes which will affect downstream values at risk. The fire removed vegetation that helps keep slopes and drainages intact, and has changed the structure and erodibility of the soil and altered the stability of the landscape. Using the understanding of rock types and characteristics, geomorphic processes, and distribution of geologic hazards helps predict how the watersheds will respond during upcoming storm seasons. Within the Thomas Fire burned area, slope failures such as rock fall, debris slides, debris flows, dry ravel, surface erosion and gullying have shaped the landscape in the past. Those processes will now be exacerbated, relative to the degree of fire burn severity, and the intensity, frequency and duration of future storms.

Treatments for debris flow and rock fall hazards include notification of the public of these hazards through warning signs and road closures, notification of the public and other agencies, clearing and improvement of catch basins and ditches along roads, maintenance and up-grade of drainage structures, and construction of rolling dips in critical locations along roads.

As a result of the removal of vegetation by the fire, channels will likely receive sediment and debris by dry ravel and other processes, and this material will be available for transport during high runoff, facilitated by fire effects. Debris jams can plug in waterways and can cause flows to divert outside normal channels and increase the destructive force of the flows. Soils are exposed, and rocks on slopes have lost their supporting vegetation. Roads and trails are at risk from rolling rock, plugged culverts, debris slides and debris flows. Stream channels and ephemeral channels will be flushed of the sediment when high flows eventually occur.

Since rock fall has already occurred along parts of the road system, and will continue to occur at an elevated rate at least through the first winter, the probability of damage or loss to people or vehicles traveling the roads from rock fall is estimated to be "possible" on the BAER Risk Matrix.

The magnitude of consequences of such an event would be "major", and this translates to a risk of "high" on the BAER Risk Matrix. Debris flows and landslides are less likely to occur than rock fall, and the potential for damage or loss is "possible", and the magnitude of consequences would be major, yielding a risk rating of "high".

According to Keller, et. al., (1997), in a study of local watersheds following the Painted Cave Fire,

"Flushing of sediment by fluvial processes is more likely than by high magnitude debris flows…Major changes in channel morphology occur following a fire as sediment derived from the hillslope is temporarily stored in channels within the burned area. However, this sediment may quickly move downstream of the burned region, where it may accumulate reducing channel capacity and increasing the flood hazard. Post-fire sediment production is a complex relationship between sequence of storms, availability of sediment and the intensity of precipitation"

Keller also postulates 3 scenarios that suggest when a debris flow may or may not happen:

- **"For average (total amount, duration and intensity) precipitation in the first few years following wildfire, a moderate sediment flushing event can be expected. All available material will probably not be mobilized before regeneration of vegetation and recovery of slope resistance to surface erosion occurs.**

- **For above average precipitation (approximately 200% of normal with moderate intensities) in the first year or two following wildfire, a moderate to large sediment flushing event, such as that following the Painted Cave Fire and observed for several other fires in California, is very likely.**

- **For above average precipitation (200% or more of normal), accompanied by high intensities of rainfall and basin instability, high magnitude debris flows may occur."**

When debris flows occur, they can come very fast and without warning, and be tremendously destructive. However, other types of slope failures and fluvial events are much more common.

Watershed Conditions:

Within the burned area of the Thomas Fire some watersheds show a great deal of past mass wasting as debris flow, landslide and rockfall activity that will be increased during future storms, while other areas have little evidence of recent past slope instability, but as conditions have changed due to the fire, additional erosion and new mass wasting will most likely be initiated.

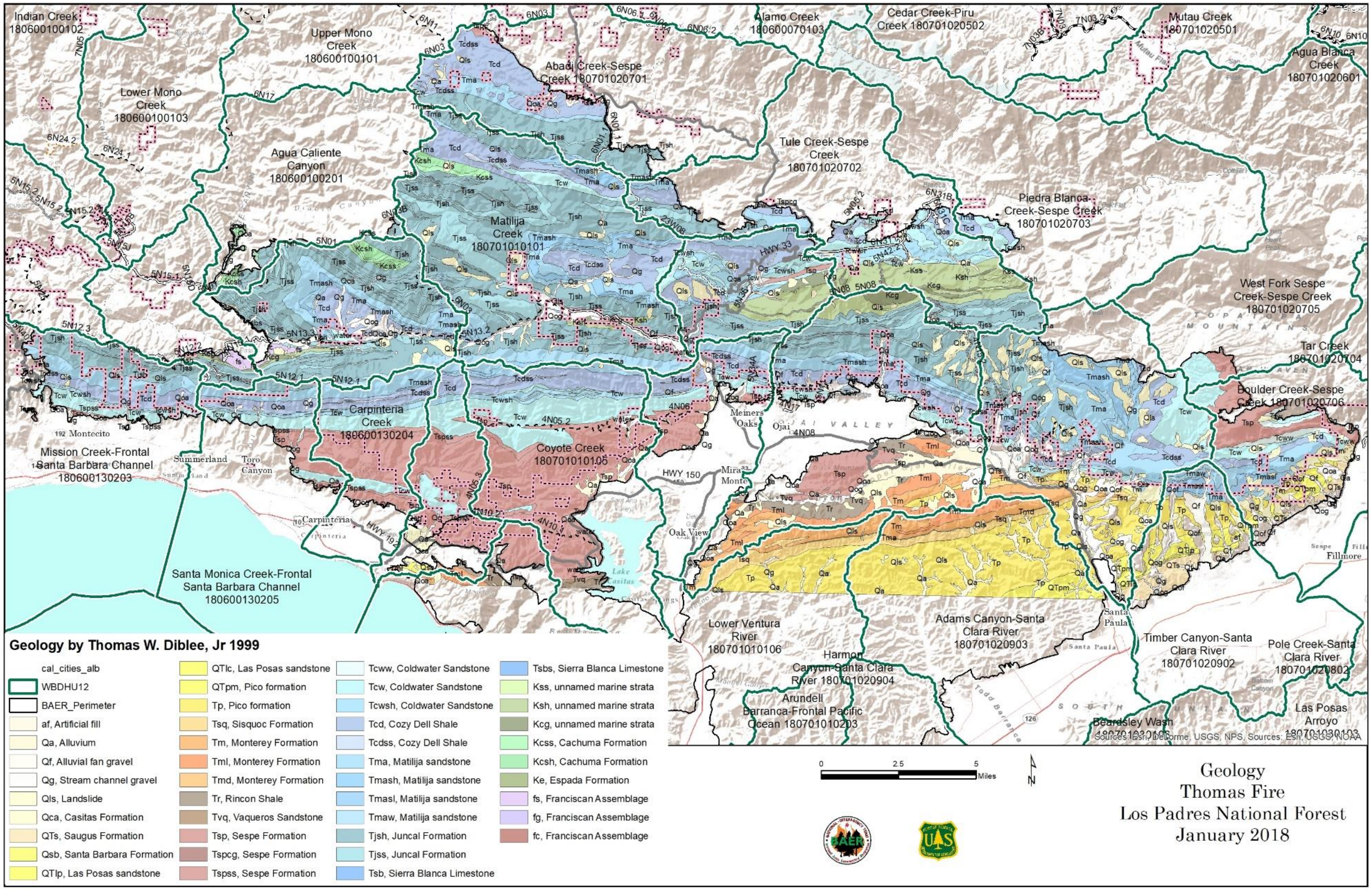
In watersheds that experienced moderate to high soil burn severity which caused the removal of vegetation by the fire, soils are exposed and have become weakened and rocks on slopes have lost their supporting vegetation. Due to these post-fire new conditions, threats are elevated from rockfall, debris slides, flooding and sediment deposition, and in some cases, debris flows. Risks to living beings, property and infrastructure, roads, trails, campgrounds, reservoirs and natural resources is moderate to high in some areas of the Thomas Fire.

FIRE EFFECTS

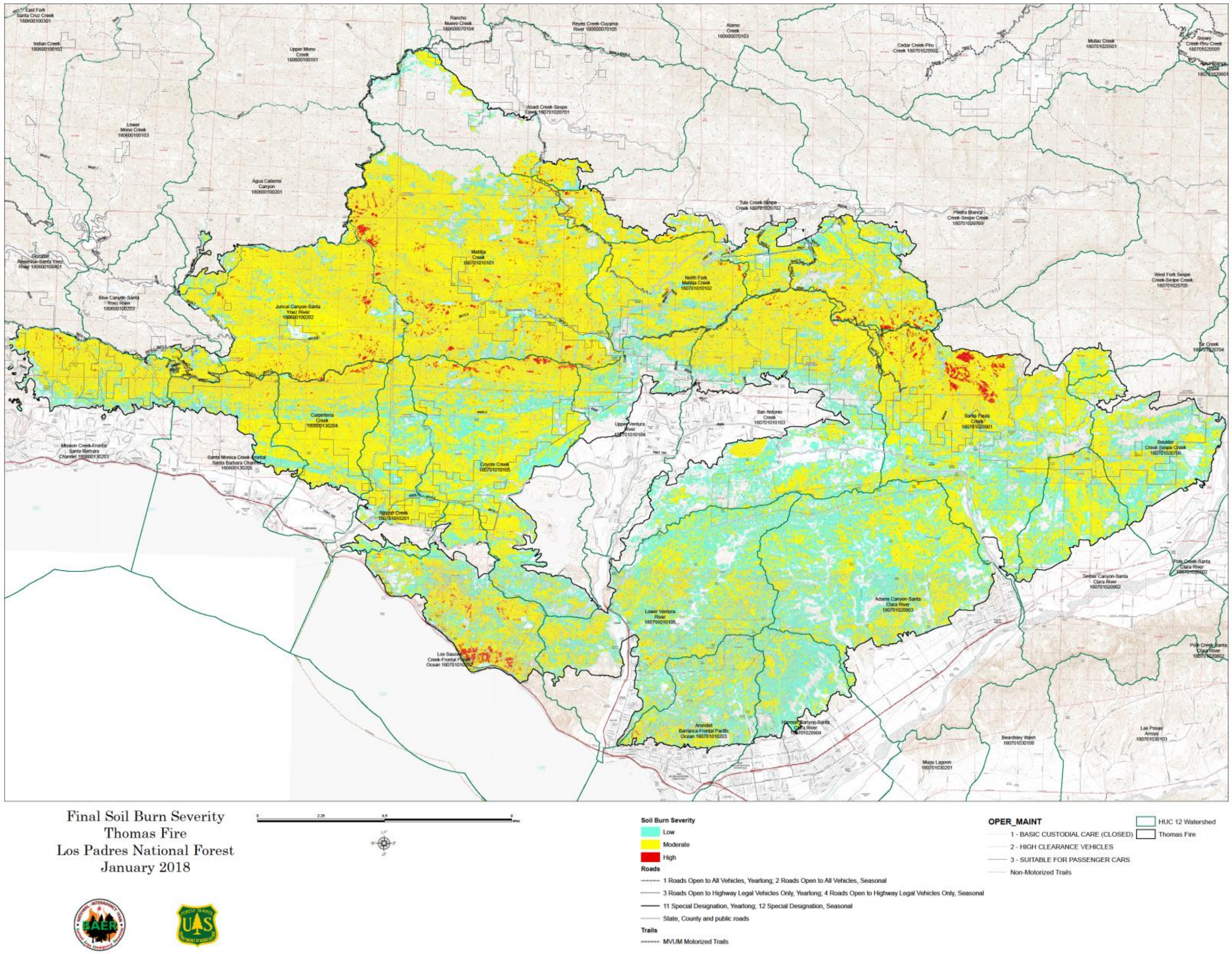
More than half of the Thomas Fire burned area has not experienced fire within the last 30 years, (Figure 3, Fire History), so those slopes often contained dense vegetation that burned hot and increased the soil burn severity.

Acres of Soil Burn Severity By Ownership					
	Unburned	Low	Moderate	High	Total
Federal	13,286	26,043	94,004	2,241	135,574
Other Gov	272	428	1,413	13	2,125
Private	5,024	14,848	21,768	397	42,038
Total	18,582	41,319	117,184	2,651	179,738
Precent	10%	23%	65%	1.5%	100%

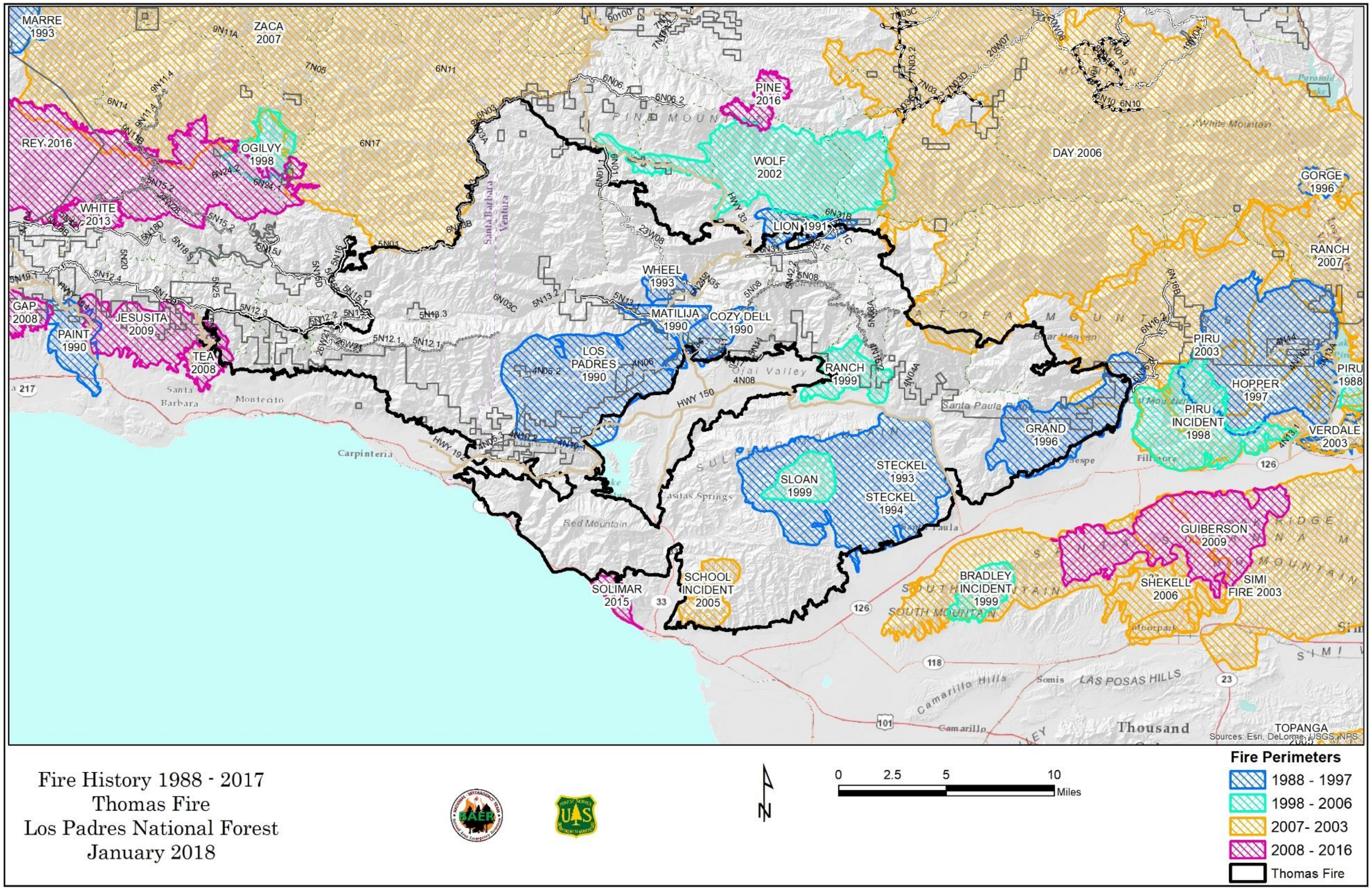
Table 1: Soil Burn Severity by Ownership



<u>Figure 1:</u> Thomas Fire Geology



<u>Figure 2</u>: Soil Burn Severity by Watershed



<u>Figure 3</u>: Fire History

OUTPUTS OF THE USGS DEBRIS FLOW MODEL

Debris flow probabilities for a 25 year (15-minute, 28MM precipitation) storm from the USGS debris flow model suggest that roughly half of watersheds have a **high** debris flow potential (predominantly in the northern half of the fire area), the remainder have a **moderate** debris flow potential (the southern half of the fire area), while very few watersheds have a **low** debris flow potential (refer to Figure 4: Debris Flow Potential – Combined Hazard Map).

It should be noted that the USGS debris flow model is designed to address relatively short duration, high intensity storms, and not the longer duration storms that typically occur in winter. As such, it should be viewed as an indicator of debris flow *potential*, rather than as an absolute predictor. The model also produces estimates of debris flow volumes for the analysis watersheds (refer to Figure 5: Debris Flow Predicted Volume Map). These maps are also available for review in the BAER project record for the Thomas fire.

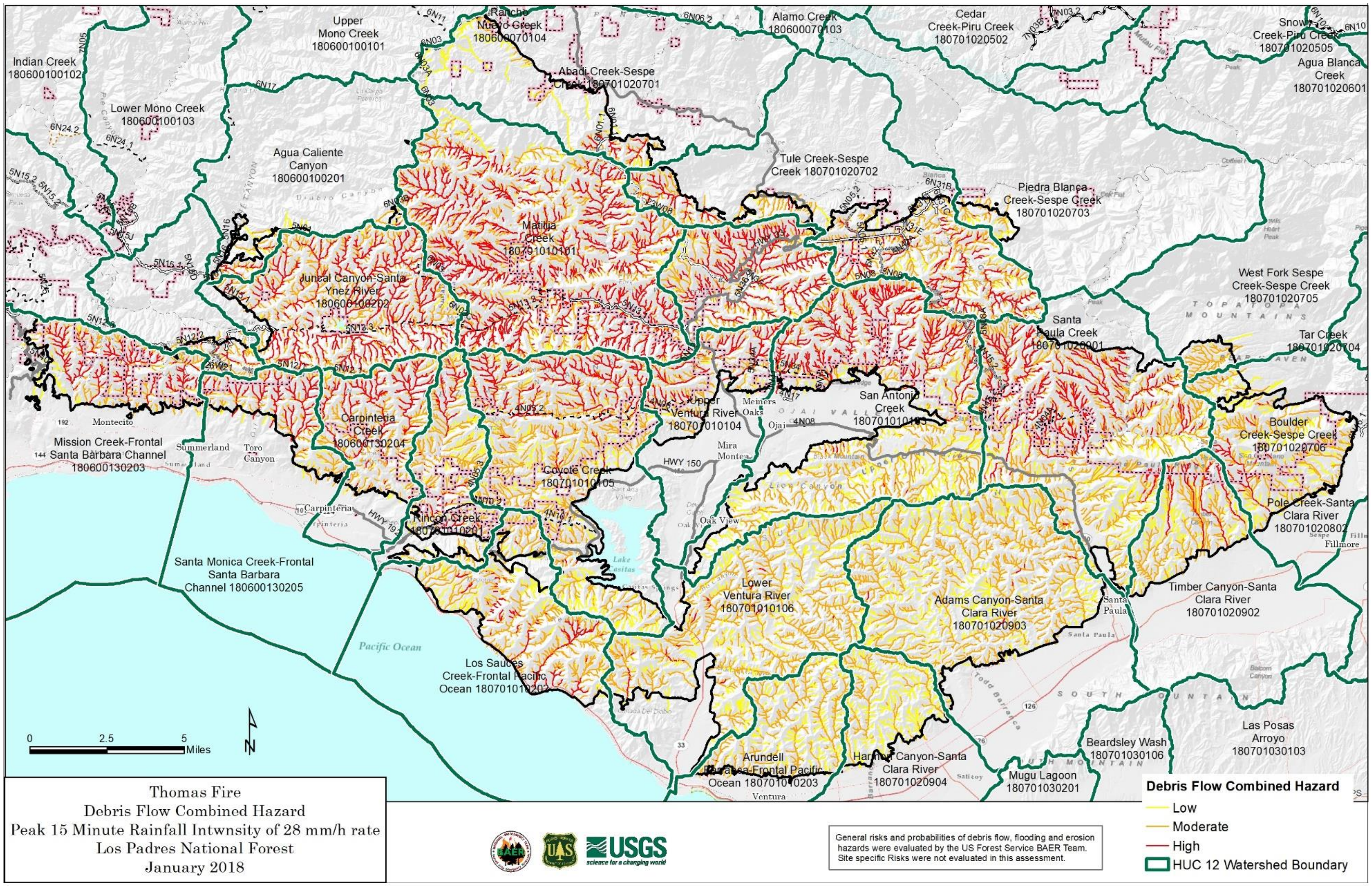


Figure 4: **Debris Flow Potential – Combined Hazard, 15 Minute Event, 28mm Precipitation**

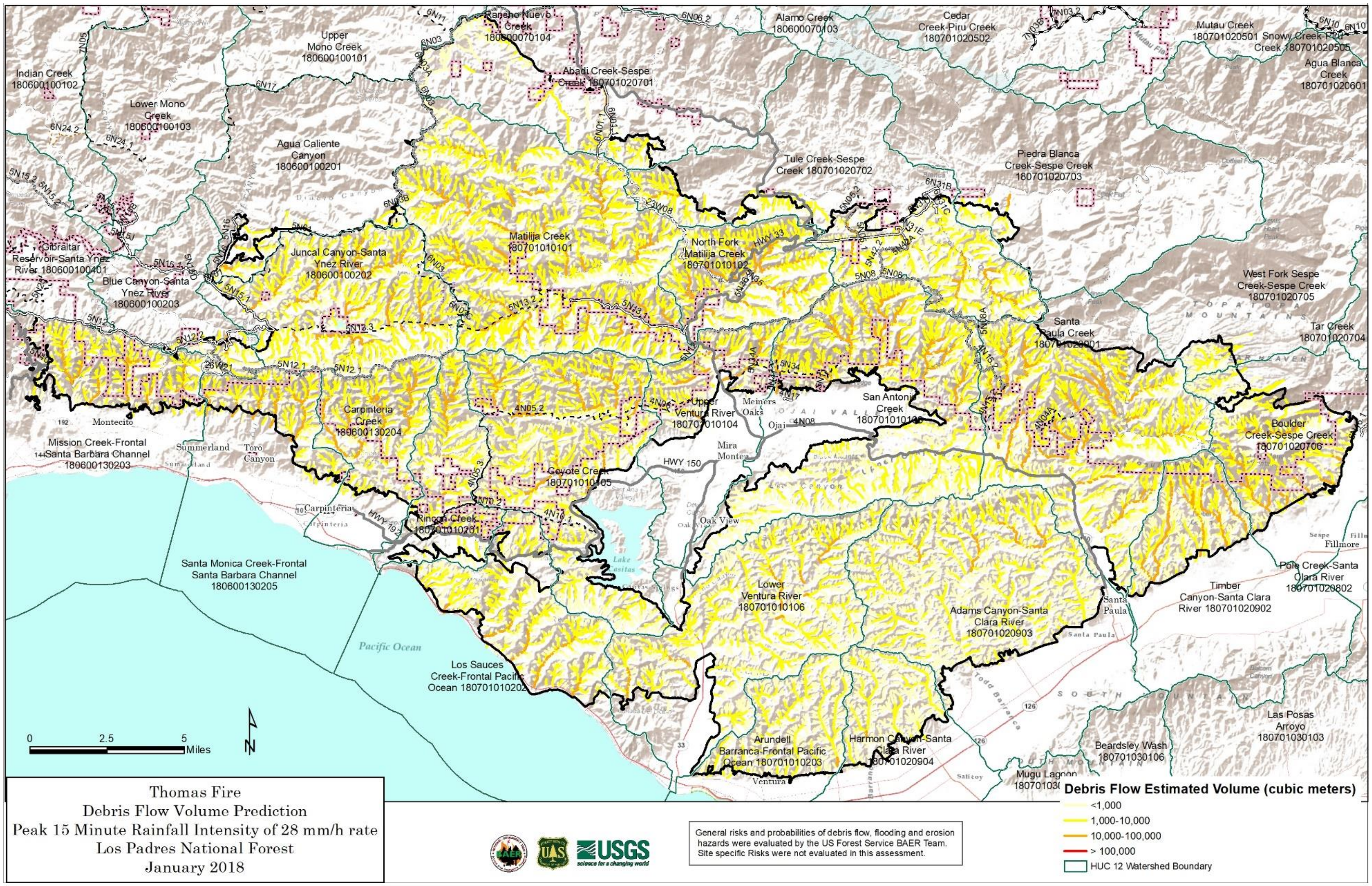


Figure 5: **Debris Flow Predicted Volume, 15 Minute Event, 28mm Precipitation**

Fast moving, highly destructive debris flows triggered by intense rainfall are one of the most dangerous post-fire hazards. Protective vegetation is gone or altered and will not return to the same levels of protection for years. Soil is exposed and has become weakened, and surface rock on slopes has lost its supporting vegetation. Roads and trails are at risk from rolling rock and increased water flow. Slopes will experience greatly increased erosion. Stream channels and mountainside ephemeral channels will be flushed of the sediment that in some places is loose and deep, in other places shallow. That sediment will deposit in some channels, choking flow, raising flood levels and covering roads with deep sediment. Risk to human life, infrastructure and natural resources is high in some areas.

Discussions with Forest personnel with long tenure on the Los Padres National Forest and on-the-ground observations of boulders and cobbles deposited from past events, revealed that debris flows and landslides following previous fires in this area have occurred.

FINDINGS AND OBSERVATIONS (listed by watershed):

Santa Paula Creek

The northern portion of this watershed is bordered by Sisar Canyon on the west, Chief Peak and Hinds Peak on the north, and Santa Paula Peak on the east, and includes Topa Topa Bluff and the upper Santa Paula Canyon. Primary rock units are thick bedded, steeply dipping and often overturned sandstones of the Matilija and Coldwater Formations, interbedded with shale, and massive units of shale of the Cozy Dell and Juncal Formations. The sandstones often form cliffs and large flatiron outcrops. The shales usually exhibit more rounded slopes with less rock on the surface.

The Juncal shale is covered with massive large rotational landslides and is generally highly unstable. The sandstone units are responsible for shedding massive boulders and cobbles and exhibiting very rocky surfaces on steep slopes.

Sisar Canyon contains large quantities of boulders and cobbles, which if mobilized in a debris flow would create a significant hazard for downstream resources.

Within the watershed, but mostly to the south of the Forest boundary, younger shales and mudstones of the Pico and Sisquoc Formations form gentler slopes and more rounded/eroded topography that is highly susceptible to surface slides and erosion.

The larger Santa Paula Creek drainage shows many areas of instability including rotational and translational landslides, rockfall, gullying and debris flow deposits if intensities and/or durations of storms are sufficient. Since this watershed experienced more high burn severity than any other, all of these instability processes are expected to produce large volumes of material downstream and add large amounts of sediment to channels and overflow areas.

Based on the USGS debris flow modeling it is predicted that most of the creeks in this watershed have a high probability (80-100%) of producing debris flows. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in most creeks and 10K to 100K in some creeks. The western slopes of upper Santa Paula Canyon are predicted to have debris flow volumes exceeding 100K cubic meters.

North Fork Matilija Creek

Addendum to information provided in the Phase 1 report:

This watershed contains the basin traversed from SW to NE by State Highway 33, and ranges from Matilija Gorge to the entrance to Rose Valley. The majority of the watershed burned at moderate burn severity (65%) and except for occasional pockets of unburned or low severity, most of the basin has been totally stripped of all vegetation.

The predominant rock type is shale from multiple Formations: Juncal, Coldwater and Cozy Dell. The Coldwater sandstone forms outcrops and supplies the majority of boulders and cobbles in the lower watershed, and the Matilija sandstone forms beautiful south dipping exposures to the north. Cretaceous sandstone and conglomerate of the Juncal Formation also produces rockfall hazards.

Massive old landslides are common in the Cozy Dell shale, and surficial debris slides, thin soil slips and dry ravel are widespread in the shale units. Rockfall hazards occur within the shale units where associated with sandstone interbeds.

Flood flows, debris flows and excessive sediment deposition, bulked by unprotected shale-derived sediment and rock from sandstone interbeds, are likely in the Wheeler Gorge area, putting the Wheeler Gorge Campground and Visitor Center at risk, as well as other private developments downstream. Keeping culverts and bridges along Hwy 33 open and unplugged will be critical to access through the area, and as an escape route during storm events.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in this watershed have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in most creeks and 10K to 100K in some creeks.

Matilija Creek

This watershed covers the majority of the Matilija Wilderness, is bounded on the west by Three Sisters (5385') and Monte Arido (6010'), White Ledge Peak (4640') to the South, and Matilija Lake (~1150') to the southeast. Matilija Canyon contains private lands and residences along the creek bottom, Matilija and Murietta Canyon roads, and a number of campgrounds and trails. The watershed appears to contain the steepest, most rugged terrain within the Thomas Burn. Slopes are extremely steep with many slopes >80%. The watershed appears to contain the steepest, most rugged terrain within the Thomas Burn with almost 5000' of relief.

Relatively few Formations and rock types cover the entire area. Interbedded sandstone and shale cover the entire area from the Tertiary Juncal, Matilija, Coldwater and Cozy Dell Formations, with minor outcrops of Cretaceous conglomerate, sandstone and shale. Alluvial deposits fill canyon bottoms with large angular and rounded boulders and cobbles, demonstrating the history of debris flows, rockfall, landslides and fluvial actions that shaped this rugged landscape.

Many old large rotational landslides are mapped within the Juncal Shale, and many more surficial landslides and rockfall sites are common on the steep slopes.

Significant precipitation will mobilize slopes in many ways, causing erosion, debris slides, debris flows, and rockfall and sediment deposition which will then add to destructive flood flows. People and other living beings, private residences, in-holdings, campgrounds, roads and trails are all at risk, and the small amount of storage remaining in Matilija Lake may mostly disappear. Keeping culverts and bridges along the Matilija Road open and unplugged will be critical to access through the area, and as an escape route during storm events.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in this watershed have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in most creeks and 10K to 100K in some creeks.

San Antonio Creek and Upper Ventura River

<u>Addendum</u> to information provided in the Phase 1 report:

As stated previously, this assessment does not deal with the private lands below Forest Service land, but discusses the conditions on the Forest Service uplands which will affect life and properties below for the next 2 to 3 years, or longer, until vegetation re-establishes.

The upper portions of these two watersheds include Horn, Wilsie, Senior, Gridley, Stewart and Cozy Dell Canyons which drain into the north side of the Ojai Valley. They are bordered by Nordhoff (4480') and Chief (5600') Peaks to the north and the Ojai Valley floor (at about 1000' elevation) to the south. A band of E-W trending (striking), steeply dipping, and mostly overturned interbedded sandstones, shales and minor conglomerates (Coldwater, Cozy Dell, Matilija, Juncal and unnamed Cretaceous) cross these watersheds. Drainage channels cut perpendicular to the strike and in some cases are diverted laterally by the resistant Coldwater Sandstone. These incised channels contain heavy bedloads of boulders and cobbles from past slope instability and fluvial events, which have created broad alluvial deposits below the mountain front, attractive places to build homes and raise crops. If new debris flows occur, the existing bedload, as well as new slope wash, can add large quantities of additional material to the flow and make them even more destructive. Orchards, homes, roads and living beings will be at risk down-channels, and laterally if channels plug and overflow onto alluvial fan deposits.

The shale units will yield high volumes of fine (silt/clay/sand) sediment following denudation by fire, in the form of surface erosion, dry ravel and thin landslide failures. The sandstone units will produce additional boulders, cobbles and sand sediment through debris slides, rockfall and debris flows. Trails and roads will experience slope failures, washouts, dry ravel and rockfall accumulations.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in these watersheds have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient. Volumes predicted for debris flows range from 1K to 10K cubic meters in some creeks and 10K to 100K in most creeks in the northern part of these watersheds.

Upper Sespe

The southern portions of the three watersheds, Abadi Creek, Tule Creek and a small area of Piedra Blanca Creek drain into and are bordered to the north by the Upper Sespe Creek, into which they ultimately drain.

The same rock formations and stability conditions as are found in the San Antonio/Upper Ventura River Watersheds exist here.

The Santa Ynez and Tule Creek Faults, as well as other minor faults cross this area. Many anticlinal and synclinal features occur in this area, and may be responsible for fracturing and weakening many of the sedimentary rocks. Large old landslides are most common in the Juncal Shale, but also occur in other units.

The back (north) side of Nordhoff Ridge and the divide that continues northwest through the Matilija Wilderness is steep and subject to slope instability, but further north, slopes are somewhat less steep, especially around Rose Valley.

Keeping culverts and bridges along Hwy 33 open and unplugged will be critical to access through the area, and as an escape route during storm events.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in this watershed have a high probability (80-100%) of producing debris flows. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in most creeks and 10K to 100K in some creeks.

Lower Sespe and Timber Canyon

Three watersheds are addressed here, including the West Fork (Lower) Sespe, Boulder Creek and Timber Canyon. They cover the eastern-most side of the Thomas Fire area, some of it inside the Sespe Condor Reserve. They also include a portion of Bear Heaven, Santa Paula Peak (4957’), San Cayetano Mountain, and the Tolin landfill just south of the Forest Boundary. The area burned slowly and hot, so that little vegetation remains.

Bear Heaven is a unique rocky topography where a broad gentle dipslope of Sespe (red) sandstone is highly jointed, fractured and dissected into what appears somewhat like karst, deeply weathered topography, however there is no limestone in the area.

A major fault cuts across the midslope between Timber Canyon and Boulder Creek watersheds which approximately follows the Forest boundary and roughly separates highly erosive younger Plio-Pleistocene sedimentary rocks below from older Matilija sandstone above. Many large old landslides emanate from the sandstone, and slopes within and below are covered with rock. Incised drainages are boulder lined and any debris flows will have large amounts of material to bulk the flow and increase the hazard to properties below.

Homes and agricultural areas downslope from burned areas may experience slope movement and increased water flow.

Condor nesting areas on steep cliffs may be present in this watershed. Most of the cliff areas observed, especially in Coldwater Canyon, burned lightly or not at all, and no increased risk from rockfall was observed.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in this watershed have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in some creeks and 10K to 100K in most creeks, especially in the northern portion of the watershed.

Coyote Creek

This watershed drains into Lake Casitas via Coyote Creek, Santa Ana Creek and other minor drainages. It is bordered by the ridgeline to the north which includes White Ledge Peak (4640'), to the west by Chismahoo Mountain (2023') and La Granada Mountain (2291'), and Laguna Ridge to the south, and includes State Highway 150 around the north and west sides of Lake Casitas.

High burn severity occurred in the upper watershed on the steepest topography below the northern ridgeline, and the rest of the watershed burned at moderate and low severity.

The northern third of this watershed contains the same Tertiary sandstones and interbedded shales (and associated instability issues) found in much of the rest of the burn: Matilija, Cozy Dell, and Coldwater, striking E-W. Superior Road traverses the watershed and separates most of those rock types from the Sespe Formation which covers the majority of the southern two thirds of the area. The Sespe Formation consists of maroon and green silty shale or claystone interbedded with layers of red/pink sandstone and conglomerate, thick in some areas. Surface slides and dry ravel are common in this unit.

Forest Road 4N05 follows Santa Ana Creek north, then west, crosses Coyote Creek drainage, then follows the western watershed boundary along the ridgetop south to Highway 150. The road is at risk in some of the steep areas and at drainage crossings from debris flows, flood flows, rockfall and sediment from erosion and dry ravel. Additional outsloping, rolling dips and armored crossings would help keep the road open. Significant sedimentation is expected into Lake Casitas carrying ash and fine sediment.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in the Coyote Creek watershed have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient. Volumes predicted for debris flows in this watershed range from

1K to 10K cubic meters in most creeks and 10K to 100K in some creeks, particularly in the northern half of the watershed.

Santa Ynez River

This area includes all of the Juncal Canyon and other drainages that flow into Jamison Lake, plus drainages below Jamison including Alder Creek and small portions of Blue Canyon and Agua Caliente Creeks. Most of this area burned at moderate severity with small isolated areas of both low and high burn severity.

The Juncal Shale with interbedded sandstone is the most common rock type, with lesser amounts of Matilija sandstone and shale, Cozy Dell shale, and Cretaceous interbedded sandstone, shale and conglomerate. A small exposure of Franciscan fractured graywacke sandstone is faulted into place south and west of Jamison Reservoir in Escondido Canyon by the Santa Ynez Fault which roughly follows the bottom of the valley from west to east. Large landslides are common in the Franciscan and in the Juncal shale.

North facing slopes below the ridge east of Romero Saddle are steep and potentially very unstable. The remainder of the area is less steep, but still subject to surface slides and a high debris flow potential. Surficial slides, dry ravel, rockfall and debris flows are expected throughout this area, but especially along the Romero-Camuesa Road. The Juncal Road is mostly in the valley bottom. It will not have the same issues as midslope roads, but still could experience problems from the outflow of debris flows and floods. Keeping culverts and bridges open and rolling dips functioning and unplugged will be critical to access through the area, and as an escape route during storm events.

A recent surficial slide exists in the drainage above Pendola Ranger Station. That slide will likely remobilize and could cause a risk to the station, either as a debris flow or a hyper-concentrated flood flow. Upstream in Agua Caliente Canyon above Pendola station a recent (2017?) small debris flow is evidence of more to come now that the steep slopes above the creek and Road 5N16 have burned. Rock Creek and Big Caliente campgrounds appear to be high enough the channel bottom to probably avoid damage from high flows, but impacts from upslope could happen.

Campgrounds, roads and trails are all at risk, and storage in Jamison Lake will be diminished.

Based on the USGS debris flow modeling it is predicted that all of the creeks in this watershed have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in most creeks and 10K to 100K in some creeks. These debris flow volumes would most certainly impact water quality and storage capacity for Jamison Lake.

Pacific Frontal Watersheds

As stated previously, this assessment does not deal with the private lands below Forest Service land, but discusses the conditions on the Forest Service uplands which will affect life and properties below for the next 2 to 3 years, or longer, until vegetation re-establishes.

This area includes watersheds that empty directly into the ocean, stretched from Montecito to the Casitas Pass. Watersheds include Mission, Santa Monica, Carpenteria, Rincon, and Los Sauces Creeks and associated smaller drainages. This assessment does not deal with the private lands below Forest Service land, but discusses the conditions on the Forest Service uplands which will affect properties below for the next 2 to 3 years until vegetation re-establishes.

The northern boundary is the ridgetop which is traversed by East Camino Cielo Road eastwards towards Romero Saddle and beyond behind Carpenteria. The fire burned at mostly moderate burn severity with minor high severity near the ridgetop and low severity in the sandstone outcrops of the Matilija Formation, prevalent along the midslope. These slopes are extremely steep in many places, and will shed large amounts of rock and sediment from the denuded slopes.

Rock types are predominantly sandstone (more resistant to erosion) and shale (less resistant to erosion) of the Juncal, Matilija, Cozy Dell and Coldwater Formations forming the upper and mid-slopes across the area. Near the base of the mountains, the Sespe sandstone and interbedded shale crops out, and below that (south) are the alluvial deposits formed over the ages by outflow of sediments (from boulder to clay sizes) forming a continuous alluvial deposit where slopes flatten at the base of the mountains. Homes, agriculture, roads and other infrastructure are built on these alluvial deposits, created by past debris flows, floods and other fluvial processes. The creek channels migrate back and forth naturally over time dumping sediment on flatter slopes and creating broad fan deposits.

When a natural channel, which sometimes is deeply incised, is blocked by being choked with too much sediment or organic debris, or by plugging a culvert or bridge, a debris flow or flood flow is forced to divert around that plug, often spilling out onto areas that had not carried water and debris for a long time. Those diversions can be especially destructive to the infrastructure outside those channels.

Stream channels and draws traversing these watersheds were already lined with lots of boulders, cobbles, and sand from natural fluvial processes before the Thomas Fire. Now that vegetation has burned, slopes are vulnerable to erosion, landsliding, rock fall, dry ravel and debris flows during significant precipitation events.

Based on the USGS debris flow modeling it is predicted that nearly all of the creeks in this watershed have a high probability (80-100%) of producing debris flows if intensities and/or durations of storms are sufficient, most notably in the Santa Monica, Rincon and Carpinteria Creek watersheds. Volumes predicted for debris flows in this watershed range from 1K to 10K cubic meters in most creeks and 10K to 100K in a few creeks.

POTENTIAL VALUES AT RISK

The following “values at risk” (VARs) are threatened by debris slides and flows, rockfall, or flooding augmented by the effects of the fire on steep, erosive and unstable slopes and water channels.

Human Life and Safety:

- People living in, or traveling through and below burned areas or recreating in these areas – Loss of life or injury could take place as a result of debris slides, debris flows, rock-fall, or sediment laden flood flows.

Property:

- State, County and City roads and bridges, private access roads and trails, and drainage systems – As a result of the fire, excessive runoff and flows are expected. In addition, stability of slopes over roads and trails will be compromised. Debris slides, debris flows, rock-fall, and flooding could cause damage to these systems.
- Residential properties, private camps, agricultural and industrial infrastructure – As a result of the fire, excessive runoff and flows are expected. Stability of slopes over properties and infrastructure could be impacted. Debris slides, debris flows, rock-fall, and flooding could cause damage to this infrastructure.
- Water bodies as lakes and reservoirs – As a result of the fire, excessive runoff and flows, debris and sedimentation will adversely affect the capacity of water bodies as lakes and reservoirs in addition to adversely affecting water qualities.
- Power distribution networks – power line support towers are also at risk from slope instability, potential landslides and debris flows.

Natural Resources:

- Critical habitat for Federally Listed Species: Sedimentation and water quality in riparian areas designated as critical habitat for Federally Listed Species – As a result of the fire, excessive sedimentation and debris will adversely affect the habitat and water quality in some of the creeks flowing through and below the burned area.

Probability of Damage or Loss	**Magnitude of Consequences**		
	Major	Moderate	Minor
	RISK		
Very Likely	**Very High**	**Very High**	**Low**
Likely	**Very High**	**High**	**Low**
Possible	**High**	**Intermediate**	**Low**
Unlikely	**Intermediate**	**Low**	**Very Low**

Table 4: Risk Matrix

EMERGENCY DETERMINATION

Values at Risk

The emergency to VARs from geologic hazards caused by the fire includes adverse effects to the health and safety of people and other living beings, property, infrastructure, reservoirs, roads, trails and natural resources. Risk of loss of life and property is of particular concern.

Specific VARs that were identified and assessed by the BAER team geologists include: Jamison Reservoir, Matilija Lake, Highway 33 through North Fork Matilija Creek canyon, and FS Road 5N13 along upper Matilija Creek.

TREATMENTS TO MITIGATE THE EMERGENCY

See Risk Matrix incorporated into the 2500-8 (Thomas Fire BAER Assessment)

The BAER team geologists were involved in numerous discussions with other team members about what treatments could be effective to mitigate potential impacts from the various watershed responses that endanger downstream values at risk. Most treatments are being proposed by other functions such as recreation, heritage, hydrology, wildlife, soils and engineering.

We recommend that a warning system be available to alert residences of communities downslope of the of burned areas for potential flooding and debris flows in advance of any storm over a peak 15-minute rainfall intensity of 28 millimeters per hour (mm/h) rate (equal to 1.1 inches per hour). This will have to be coordinated with NOAA and USGS to get it into the existing early warning system.

SUMMARY/RECOMMENDATIONS

Based on ground surveys, air recon and analyzing maps and data, rock-fall, debris slides, debris flows and dry ravel are eminent along numerus burned slopes and creeks above and around private properties, ranches, camps, industrial infrastructure and roads within watersheds burned by the Thomas Fire. In addition, with the aid of USGS Debris Flow Modeling, debris flow probabilities and potential volumes have been calculated. Based on these models it appears that under conditions of a peak 15-minute rainfall intensity storm of 28 millimeters per hour (1.1 inch/hr.), the probability of debris flows occurring is 80-100% in the majority of main channels in the burn area. Under these same conditions, predicted volumes of these debris flows are expected to range from 10K-100K cubic meters in the majority of the main channels in the burned area. From the debris flow combined hazard map it appears that the majority of creeks in the burn area are predicted to produce debris flows of a high combine hazard.

The conclusion of our field observations is that whether the primary post-fire process is rock-fall, debris slides, debris flows or sediment laden flooding, the cumulative risk of various types of slope instability, sediment bulking, and channel flushing is high along many slopes and creeks in and below the burn area following the Thomas Fire. Based on the above, special attention and caution is recommended in areas where people are traveling through, working or recreating below or in the burned areas of the Thomas Fire during or after storm events.

As a result of post fire conditions, excessive sedimentation and debris will adversely affect the capacity of some reservoirs located below the burn area. In addition, post-fire conditions will adversely effects critical habitats for Steelhead, a federally listed species in 26 of the area creeks.

Area Closures

See individual specialist reposts for Roads, Recreation and Hydrology for closure recommendations.

Warning Signs

Install signs warning of debris flows, landslides and rockfall. High priority areas for this are roads through areas of high and moderate severity fire with high debris flow and rockfall potential. See specialist reports for Roads, Recreation, Hydrology and Heritage for specific types and locations of signs.

Notification of individuals and Agencies

Notify private citizens and other agencies of potential threats posed by geologic hazards. Elevated potential for debris flows is anticipated for most steep watersheds which burned at high and moderate soil burn severity, and structures within or near the mouths of these watersheds are at risk. Of particular note are the Pacific Frontal and Santa Ynez River watershed groups.

Road Repairs/Storm Proofing

See Roads specialist report.

REFERENCES

Dibblee, Jr., T.W., 1966, Geology of the Central Santa Ynez Mountains, Santa Barbara County, California: California Division of Mines and Geology Bulletin 186.

Keller, E.A., Valentine, D.W., Gibbs, D.R., 1997, Hydrological response of small watersheds following the southern California Painted Cave Fire of June, 1990. Hydrological Processes 11, 401-414p.